DOCUMENT RESUME

ED 045 970 AL 002 695

AUTHOR Bailey, Charles-James N.
TITLE Building Rate Into a Dynamic Theory of Linguistic Description.
INSTITUTION Hawaii Univ., Honolulu. Dept. of Linguistics.
PUB DATE Dec 70
NOTE 71p.
AVAILABLE FROM Author, Department of Linguistics, University of Hawaii, Honolulu, Hawaii 96822
JOURNAL CIT Working Papers in Linguistics; v2 n9 p161-233 Dec 1970

EDRS PRICE EDRS Price MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS Algorithms, *Diachronic Linguistics, *Distinctive Features,, *Linguistic Theory, *Phonology, *Sociolinguistics

ABSTRACT

This study of linguistic change is done within the "dynamic paradigm" of linguistic description, in which the strict dichotomy between diachronic and synchronic linguistics found in "static paradigms" is not maintained. The chief purpose here is to indicate how rate could be built into a linguistic description of sound change, such change being here considered as "represented in the wave-like spread of a given rule as it is borrowed from speaker to speaker." Two principal alterations to which a rule is subject in the process of spreading are considered: (1) it may become more general, i.e., simpler, increased generality resulting from the loss of environmental specifications for the operations of the rule; the fact that the rule operates in one environment earlier than in others can be viewed as a difference in the relative rate of the rule with respect to the different environments; 2) reweighting, where changes in the weight of features (in terms of markedness) influence rate of change. The first part of this paper presents the principles on which the study is based, formalizes the notion of rate, and presents evidence for reweighting. The second part considers linguistic and sociolinguistic algorithms for sound change. The final section deals briefly with the effects of overlapping waves of change from different origins. [Not available in hard copy due to marginal legibility of original.] (FWB)

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BUILDING RATE INTO A DYNAMIC THEORY OF LINGUISTIC DESCRIPTION[1]

Charles-James N. Bailey

(i)

In discussing a model of a sound change--say, that represented in the wave-like spread of a given rule as it is borrowed from speaker to speaker--it is necessary to to consider two principal alterations in the rule as it spreads. First, the environment may become more general, i.e. simpler, since increased generality results from the loss of environmental specifications for the operation of the rule. The fact that the rule operates in one environment earlier than in others can be viewed as a difference in the relative rate of the rule with respect to the different environments. Like runners in a race (to employ William Labov's metaphor) who start together but arrive at different times, the environments can be regarded as exhibiting different rate factors; those environments where the rule arrives first under given conditions are to be thought of as "faster" than those where the rule operates later. This differs considerably from any concept of absolute speed of rules in real physical and social space. In what follows, the behavior of features in the environment for the operation of a rule must be distinguished from the behavior of features in the input segment, or various confusions will result.

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Much of the following discussion depends on this metaprinciple (compare Kiparsky 1968):

1) Linguistic changes occurring in the acquisition of language by children are unidirectional from marked to unmarked.

The principle affects feature values and weights (Appendix B), as well as rule-ordering. But it does not apply in adult changes "from above" for reasons explained at the end of this section of the paper. Principle (1) is the principle of directionality in linguistic description, not least in rule formulations. It indicates directions in which linguistic entities are prone to change, without any additional apparatus beyond current descriptive notations.

Limited, but wide-spread and reliable, evidence[2] indicates that the weakest environments for the inception of phonological rules are those followed by word boundaries or labial consonants. Appendix B shows that boundaries are heavily weighted. And in general the correlation of heaviness of features with weakness or earliness of environments formalized in principle (3) below allows us to take for granted principles like the following:

2) Changes of vowels have their fastest rates before word boundaries and before [m anterior, u grave] non-nuclear segments.

This statement has [anterior] listed before [grave], although Appendix B shows that the latter is more heavily weighted. In the formalisms which will be used here, a feature standing above or to the left of another in a statement is the heavier-weighted of the two (see Labov MSa: n. 14). When features are found in a marked weighting hierarchy in a rule, they have a tendency on the basis of principle (1) to change into the unmarked weighting--viz. the hierarchy shown in Appendix B.

The framework c this study also presupposes another principle defining the rate of change in the operation of a rule; it applies to feature specifications in the environment of the rule only:

3) Rule changes operate at a faster rate in the presence of features that are heavier in the weighting hierarchy of a given rule than in the presence of lighter features.

Evidence for this principle will appear in rules discussed later. At this point, it is important to stipulate clearly the principle that governs the initial form that a new rule takes:

4) New rules are added (a) at the end of the grammar in what is usually a marked ordering (unless they are simultaneously reordered to their maximally unmarked position; but see also Chafe 1968); (b) in a very limited environment, i.e. with a complex, non-general array of environment features in the rule statement; and (c) usually with the relevant environment features of a variable rule having their marked relative weightings.

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Otherwise, rules could not become more general or get reweighted. The logic of (4a) and (4b) is clear enough, but the reasons for (4c) remain unclear.

In ancient Greek, the rule deleting *w operated diachronically (to produce a synchronic patterning) at different rates--in terms of the present conceptual framework--as shown in the following list, where the fastest environments stand above the slower ones (cf. Lejeune 1955:148):

5a) [+nuclear, +segmental] ___ [-nuclear, -continuant]

5b) [+nuclear, +segmental] ___ [+nuclear, +continuant]

5c) [-nuclear, +segmental] ___ [+nuclear, +continuant]

5d) [-nuclear, -segmental] ___ [-nuclear, +continuant]

5e) [-nuclear, -segmental] ___ [+nuclear, +continuant]

Such environmental rates can be formulated in rule (6), where lower numbers indicate heavier weightings and vice-versa:

$$6) \quad w \dashrightarrow (\emptyset) \; / \; \begin{bmatrix} 1 \text{ nuc} \\ 2 \text{ seg} \end{bmatrix} \; \_\_\_ \; \begin{bmatrix} -1 \text{ nuc} \\ -2 \text{ cnt} \end{bmatrix}$$

Reasons are given in Appendix B for regarding [seg] as being heavier-weighted than [nuc] in the unmarked hierarchy. The relationship between [nuc] and [cnt] in (6) probably represents the unmarked weighting relationship between these features. A simple calculation of the weights in (6) for the environments shown in (5) results in the following relative weightings:

5a) +1 +2 +1 +2 = +6

5b) +1 +2 -1 -2 = 0

5c) -1 +2 -1 -2 = -2

5d) -1 -2 +1 -2 = -4

5e) -1 -2 -1 -2 = -6

The weighting values indicated here are merely devices to show the hierarchical relations obtaining in a rule. In cases where all relevant features are tautosegmental, it may be more convenient simply to indicate such relations by writing the heavier-weighted features above or to the left of lighter-weighted ones, as already observed.

Evidence may now be given for another principle:

7) Rules generalize in this sequence: lighter-weighted environment features are deleted before heavier ones.

Together with (3), this principle formalizes the notion of rate. The relative ordering of (3) and (7) could differ in a given language situation, as will be shown. Data from the diphthongization of /Ī/ (presented in Appendix A) offer evidence from North England that the change, beginning in the environment defined by (2), successively generalizes to pre-apical and pre-velar environments. (Although the latter environments are not present in the North England data, the prevelar environment is the slowest one for the operation of the second stage of the rule in the Southern States and elsewhere; see Appendix A.) If the rule initially operates in the environment before [m ant, u grv] segments, and no reweighting occurs before principle (7) applies, this principle first deletes [grave], so that the change now occurs before apicals as well as labials. When the next feature in the environment (viz. [anterior]) is deleted, the rule is left unconditioned and applies also in the prevelar environment. But if in the spread of the rule to more remote locales there occurs a reweighting such that the prelabial environment is written [u grv, m ant], the sequence of environments to which the rule generalizes is different. The lighter feature is now [anterior], so it is lost first. This extends the operation of the rule from prelabial environments to prevelar ones. When [grave] is subsequently deleted, the unconditioned rule applies also before apical consonants. In this manner the formalism accounts quite easily, and with no additional encumbrances, for different environmental rates in the generalization of a rule.

Until now the discussion has been centered on the first way in which rules alter as they spread--by generalizing. The discussion has several times also touched on the second way in which they may alter in their wave-like spread through physical and social space--by reweighting. (Note that if [m F_j, u F_i] reweights to unmarked [u F_i, m F_j], the result is less complexity, since the m ["marked"] now has a lighter weighting than before.) Crucial evidence for several reweightings is found in a very important and detailed study by William Labov (MSa), who was the first linguist to uncover this kind of linguistic change (Labov 1969).

In a study of the raising of tensed /æ/ in the Northeast, Labov (MSa) found that the fastest rate occurs before voiceless fricatives (F) at the inception of the raising rule. A slower rate occurs before voiced stops ($), and the slowest rate occurs before nasals (N).[3] The raising proceeds in two stages: (a) to a mid position; (b) to a high position. Fig. 1 portrays what I understand to be six isolects resulting from the raising. (Unattested isolect 2 is postulated by Labov; in isolect 5 Labov claims that the change in the environment before F is ahead of that before $, but my reading of his Fig. 9 does not bear this out. I also presume that the change before N is categorical in 5.) In Fig. 1 variable changes (in which input and output both appear) are indicated by parenthesization, while asterisks indicate changes that are categorical in the environment. The direction of time is from left to right, earlier changes being to the left of later ones.

Time →

Stage (a): --> [-low]			Stage (b): --> [+high]		
(N)	(N)	*N	(N)	*N	*N
($)	*$	*$	($)	($)	*$
(F)	*F	*F	(F)	(F)	*F
1	2	3	4	5	6

1 - Jewish male, aged 73

2 - Unattested lect postulated by Labov.

3 - Jewish male, aged 60

4 - Jewish male, aged 57

5 - Jewish male, aged 23; also older Italian males

6 - Italian female, aged 42

FIG. 1. Stages in the raising of tense /æ/ in New York City (from Labov MSa).

Note that women and Italians are ahead of Jewish men. Although the N environment begins last, it accelerates to the lead after the feature [nasal] moves into its unmarked place in the weighting hierarchy ahead of the other two features in the environment of rule (8). The formalism[4] automatically accounts for the acceleration of the nasal environment ahead of the non-nasal environments, and perhaps for the acceleration of the $ environment ahead of the F environment:

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8) $\begin{bmatrix} \text{V} \\ \text{m tense} \\ \text{u low} \\ \text{u grave} \end{bmatrix} \text{-->>} \ (\text{[m low]}) \ \text{-->>} \ (\text{[u high]}) / \_\_\_ \begin{bmatrix} (\text{ D voiced}) \\ (\text{-D contin}) \\ (\text{ m nasal}) \end{bmatrix}$

$$\begin{bmatrix} \text{*D voiced} \\ \text{*-D contin} \\ (\text{ m nasal}) \end{bmatrix}$$

$$\begin{bmatrix} \text{*m nasal} \\ \text{*-D contin} \\ \text{*D voiced} \end{bmatrix} \text{-->>} \begin{bmatrix} (\text{ m nasal}) \\ (\text{-D contin}) \\ (\text{ D voiced}) \end{bmatrix}$$

$$\begin{bmatrix} \text{*m nasal} \\ (\text{-D contin}) \\ (\text{ D voiced}) \end{bmatrix}$$

$$\begin{bmatrix} \text{*m nasal} \\ \text{*-D contin} \\ \text{*D voiced} \end{bmatrix}$$

Note that all environments specify exactly the same segments. What is different among them is the relative rate of the environments and the categoricalness of the features involved. The asterisks in the second environment fit the detoured environment, but the detour itself suggests an error in the surmise about the nature of isolect 2 in Fig. 1. (Also rule [8] specifies environment F lagging behind $, but compare the discussion of the order of these two environments below.) A different surmise allows us to assume a parallelism between stages (a) and (b) of the change, to eliminate the detour environment (which is in any case identical with the last one), and to alter the second environment to read as in the following revised rule:[5]

$$8')\ \begin{bmatrix} & \text{V} \\ \text{m} & \text{tns} \\ \text{u} & \text{low} \\ \text{u} & \text{grv} \end{bmatrix} \text{ -->> } ([\text{m low}]) \text{ -->> } ([\text{u high}])\ /\ \_\_\_\ \begin{array}{c} \begin{bmatrix} (\ \alpha\ \text{voi}) \\ (-\alpha\ \text{cnt}) \\ (\ \text{m nas}) \end{bmatrix} \\ \Downarrow \\ \begin{bmatrix} (\ \text{m nas}) \\ (\ \alpha\ \text{voi}) \\ (-\alpha\ \text{cnt}) \end{bmatrix} \\ \Downarrow \\ \begin{bmatrix} (\ \text{m nas}) \\ (-\alpha\ \text{cnt}) \\ (\ \alpha\ \text{voi}) \end{bmatrix} \\ \Downarrow \\ \begin{bmatrix} *\text{m nas} \\ (-\alpha\ \text{cnt}) \\ (\ \alpha\ \text{voi}) \end{bmatrix} \\ \Downarrow \\ \begin{bmatrix} *\text{m nas} \\ *-\alpha\ \text{cnt} \\ *\alpha\ \text{voi} \end{bmatrix} \end{array}$$

Instead of Labov's proposed isolect 2, rule (8') now generates three isolects: (2a) [nasal] is reordered to a faster (heavier) weighting, all features remaining variable; (2b) [voiced] and [continuant] are reweighted with respect to each other; (2c) the change in the nasal environment becomes categorical (and naturally has a faster rate than the variable changes; see sect. [ii] below). Some algorithm like (L-4) below will stipulate that after the first change (to a mid-vowel position) has gone through all the environments in order, the second change (to a high position) follows three behind. (As noted in the discussion below, these stipulations may be formalized in the rule by writing ∀ ["all"] over the first double-headed arrow and 3 over the second. But since the second stage could not conceivably begin with a pre-reordered environment, no such numerical indices need be written over the arrows; in such cases it will be assumed that the first change goes in order through all the environments, and that then the second one goes through all *possible* environments.)

The reweighting of the $ and F environments presents something of a problem, in as much as both environments are equally specified as [ɒ voi, -ɒ cnt] (or as [-ɒ cnt, ɒ voi] after reweighting). Although the $ environment, [m voi, u cnt] is prone to become [u cnt, m voi] with a lighter-weighted *m*, this would be offset by a heavier-weighted *m* when the F environment simultaneously reweighted from [u voi, m cnt] to [m cnt, u voi]. Though ordinary *m*'s have no proneness to become heavier-weighted, they could do so in an alpha-variable situation. Bailey and Parker (1970) have adduced some arguments in favor of a lower cost for alphas and other variables than for *m*'s, but their arguments apply only to the outputs of a rule. Within the present framework it will make better sense to propose principle (9), though very tentatively:

9) When features are paired with *n* or other variable coefficients (whether one is minus-valued or not), an *m* indicates a slower rate than a corresponding *u* on a feature, and a heavier-weighted *m* has a slower rate than a lighter-weighted *m* on a given feature.

Although the scanty evidence is insufficient to establish this principle, it correlates well, as will be seen, with principle (10) below. The vacillation between the rates of the $ and F environments which Labov found may be accounted for on the basis of the alpha-paired specification in question.

Until now, the discussion has been concerned with specifying environment rates for the operation of a variable rule; e.g. principles (3) and (7). But the coefficients (*m* or *u* values) of input features also have effects on the rate of a rule's operation. The raising of /ǣ/ in New York City begins ahead of the raising of /ɔ̄/, but the latter accelerates ahead of it and reaches the high-vowel position first. The Southern States patterning for the outputs of //Ī ū// shown in Appendix A depend on the temporal precedence of the front vowels at every stage of change, and no acceleration of the back vowels is apparent. Evidently, there is needed a principle like (10) which, like (9), assigns a faster rate to the u values of an input feature than to its m values.

10) Changes occur earlier in input segments having the u value of a feature than similar changes in input segments differing only in having the m value of the feature in question; if an acceleration of the rate occurs, the input segment with the [m F_i] will move ahead of the input segment with the [u F_i] for the change in question.

The specification of the conditions under which the acceleration occurs must await further investigation.

A curious reader may ask why principles (3) and (10) cannot be combined under a general rubric that the changes which begin last accelerate ahead and arrive first at the completion of the change as the rule becomes an unconditioned one. But this principle would make a different prediction in certain instances. Thus, rule (8') spreads from the East to Detroit, where its first stage arrives already with features reweighted (Labov, personal communication); that is, the Detroit rule lacks the first two temporal stages found in the environment of formulation

(8'). Since, on the basis of principle (1), no reordering of the unmarked weighting to a marked one is possible, at least in changes made during the acquisition of the language by children, it will have to be predicted that no acceleration on the basis of principle (3) will occur in Detroit as the rule continues in time. And this disagrees with the prediction of the proposed more general rubric mentioned above.

But if an adult hypercorrection occurs in Detroit such that the marked weightings (the first two environments of [8']) were restored, then the predictions about acceleration being made here would not disagree with the proposed rubric. But since hypercorrections are usually conscious actions and the minute rate distinctions under discussion often cannot be perceived by native speakers of the forms of speech in question (Labov, personal communication), a hypercorrect reweighting to a marked weighting hierarchy is an eventuality that we may disregard. It is otherwise with principle (10), since Labov's (MSb) evidence from Martha's Vineyard shows that subconscious hypercorrections reverse the original changes, ei --> ae and eu --> ao, so that the arrows point in the opposite direction, and that in this situation the back-vowel changes are greater (faster) than the front-vowel ones. We do not have to conclude that hypercorrections and other changes from above are simply mirror-images of "natural" linguistic processes, but rather consider the concepts, "marked" and "unmarked." Children are born equippped with the latter, but must learn "marked" phenomena--so that, if the complexity of a language comes to exceed a certain (unknown) threshold of markedness, children acquiring it replace some m's with u's. But after the age of 12±1, a speaker has to learn everything he acquires; in other words, everything is marked. This is truest of all for outputs of hypercorrective processes, and particularly of spelling pronunciations.

(ii)

A model of linguistic change requires two sets of algorithms--one, purely linguistic; the other, sociolinguistic. For the known principles of change are inconsistent with a homogeneous model (Weinreich, Labov, and Herzog 1968). Although it is intuitively easier to comprehend a model that shows one item (the first environment in which a new rule operates) at the beginning, and then more and more items as the rule spreads in time and (physical and social) space, a proper understanding of generalization requires that the initial form of the rule be stated with a complex array of features for the most non-general environmnet, and that the generalization of the rule be portrayed as a simplificatory loss of features. Otherwise, it would not be a simplification and would be conceptually very difficult to think about.

The linguistic algorithms of the wave model that generates the synchronic patterns of a language (further specified with the sociolinguistic algorithms discussed below), which must be combined with the principles proposed in sect. 1 to get the right patterns, are as follows (a fourth algorithm is given later):[6]

L-1) A single change from variable to categorical or from one environment to the next defines a new relative time interval and a new isolect.

L-2) In each successive environment or situation in which a rule operates, as stipulated in principles (3, 7, 9) above, the rule initially operates variably, the output alternating with the input.

L-3) Either (a) the proportion of outputs over inputs in a variable environment for the operation of a rule increases until inputs no longer occur, so that the rule is categorical in that environment *before* it begins to operate (variably) in the next-lighter-weighted or more general environment; or (b) in situations where a rule is variable in more than one environment, the proportion of outputs over inputs is greater in heavier-weighted or more general environments than in lighter-weighted or less general ones.

The (b) case of (L-3) has been illustrated in connection with (8'), while the (a) case can be illustrated with data from Bickerton MS. It is clear that specifying a rule to operate under algorithm (L-3a) or (L3-b) would eliminate the need for the vertical dimension of formulation (8'), together with the asterisks and parentheses involved!

Labov's (MSa: Fig. 1) model of variable ordered decomposition is (with certain adjustments for present purposes) shown in Fig. 2, as applied to rule (11), in which a, b, and c represent successively heavier-weighted (or more generalized) environments:

$$\text{(11) V --> (Z) / \_\_\_\_} \begin{Bmatrix} c \\ b \\ a \end{Bmatrix}$$

Fig. 2 is a model of the operation of this variable rule according to algorithm (L-3b), while Fig. 3 is constructed according to algorithm (L-3a). (Bickerton [personal correspondence] is mainly responsible for this formulation, but he would perhaps not agree to the degrees of variability shown in Fig. 3.)

Bickerton's (MS) Table 8, slightly modified to conform to the presentation here, is given as Table 1. It shows the lectal patterns of a morphological change from an older F to a newer T in three verb classes. The patterns represent a slight idealization of data from Guyana Creole. Let us compare these patterns (isolects) with those that would be generated with algorithm (L-3a) on a rule which has been cited several times by Labov (e.g. MSa). This is a rule which in the simplified form shown here has been proposed by Labov as a universal tendency of languages:

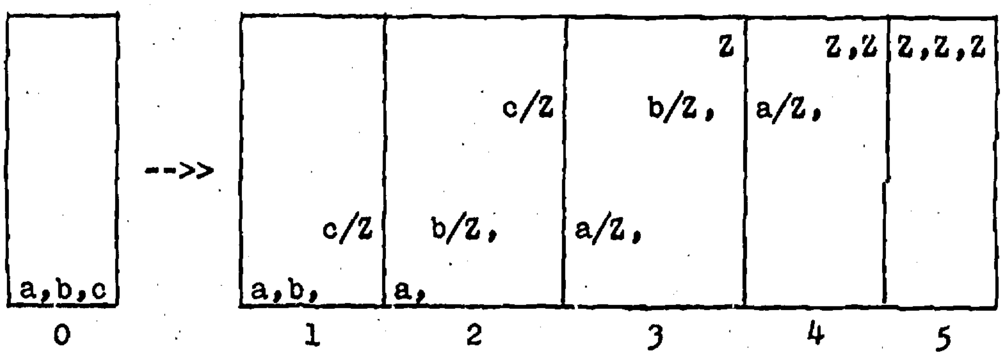

FIG. 2. Labov's model of variable ordered decomposition (modified). See algorithm (L-3b). The vertical dimension represents successively greater proportions of outputs over inputs, from none to 100 per cent (at top). The direction of time is from left to right in the horizontal dimension of the figure. The numbers denote different isolects.

		Z	Z	Z	Z,Z	Z,Z	Z,Z	Z,Z,Z
	c/Z			b/Z,			a/Z,	
c/Z			b/Z,			a/Z,		
a,b,	a,b,	a,b,	a,	a,	a,			
1	2	3	4	5	6	7	8	9

FIG. 3. Wave model based on algorithm (L-3a), with same symbols as used in Fig 2, but omitting isolect 0 (which would be identical with isolect 0 in Fig. 2).

Temporal isolects	Verb Classes I	II	III
0.	F	F	F
1.	T/F	F	F
2.	T	F	F
3.	T	T/F	F
4.	T	T	F
5.	T	T	T/F
6.	T	T	T

TABLE 1. From Bikerton (MS: Table 8); slightly idealized patterns of Guyana Creole infinitive markers (complementizers).

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12) C --> (∅)/C [-1 word boundary] ___ ## [-2 nuclear]

(The foregoing formulation differs from Labov's own formulation; for one thing, it employs numerical weights, as proposed in Fasold 1970. In this formulation, the higher numbers represent the heavier weights; rules are more operative in numerically larger environments.) Formulation (12) gives the rule with the features in their marked relative weightings. This is the form of the rule among Harlem pre-adolescents. The rule reweights as they grow older. It is the reweighted form of the rule that is also found in some varieties of English spoken by whites.

Rule (12) gives relative weightings to four different environments, listed here from heaviest to lightest:

13a) +3: C___##C, as in <u>bold</u> + C or zero

13b) +1: C#___##C, as in <u>bowled</u> + C or zero

13c) -1: C___##V, as in <u>bold</u> + V- in the next word

13d) -3: C#___##V, as in <u>bowled</u> + V- in the next word

Algorithm (L-3a) predicts the isolectal groupings shown in Table 2. Suppose that reweighting occurs at temporal stage (isolect) 3. The resultant patterns are then those shown in Table 3.

The questions arise whether (L-3a) or (L-3b) is the unmarked case and how to indicate the marked algorithm for a given rule when necessary. Rather than offering some ad hoc proposal, the matter will be left open here. It seems possible that different lects of a language could apply a given rule in the two alternative ways.

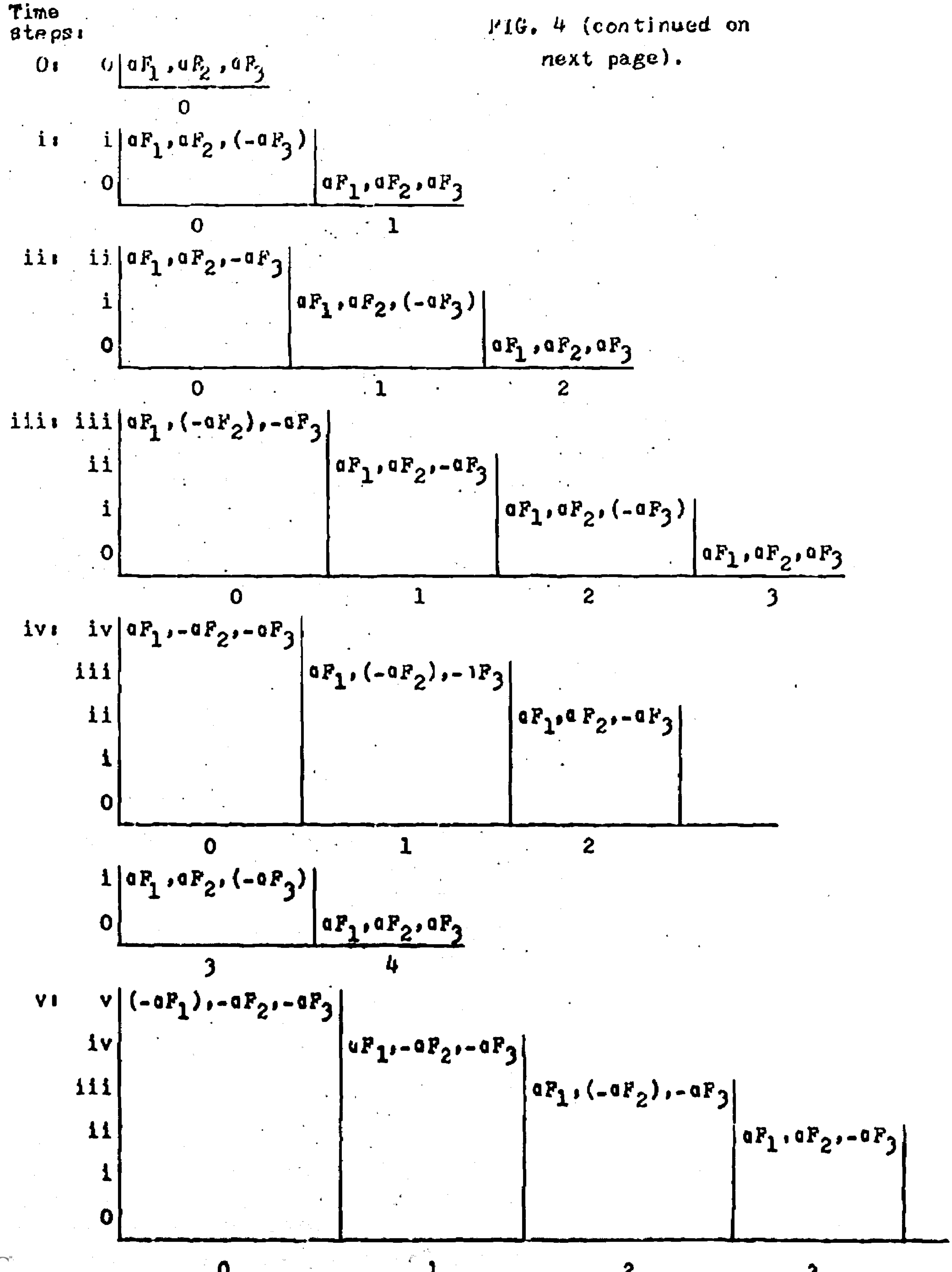
Temporal isolect:	bold +C/Ø	bowled +C/Ø	bold +V	bowled +V
0	bold	bowled	bold	bowled
1	bol(d)	bowled	bold	bowled
2	bol'	bowled	bold	bowled
3	bol'	bowl(ed)	bold	bowled
4	bol'	bowl'	bold	bowled
5	bol'	bowl'	bol(d)	bowled
6	bol'	bowl'	bol'	bowled
7	bol'	bowl'	bol'	bowl(ed)
8	bol'	bowl'	bol'	bowl'

TABLE 2. Isolectal patterns of rule (12) according to algorithm (L-3a). Parentheses indicate variables.

Temporal isolect:	bold +C/Ø	bowled +C/Ø	bold +V	bowled +V
0	bold	bowled	bold	bowled
1	bol(d)	bowled	bold	bowled
2	bol'	bowled	bold	bowled
3	bol'	bol(d) +V	bowled +C	bowled +V
4	bol'	bol'	bowled	bowled
5	bol'	bol'	bowl(ed)	bowled
6	bol'	bol'	bowl'	bowled
7	bol'	bol'	bowl'	bowl(ed)
8	bol'	bol'	bowl'	bowl'

TABLE 3. Isolectal patterns of rule (12) according to algorithm (L-3a), with reweighting at isolect 3.

FIG. 4 (continued on next page).



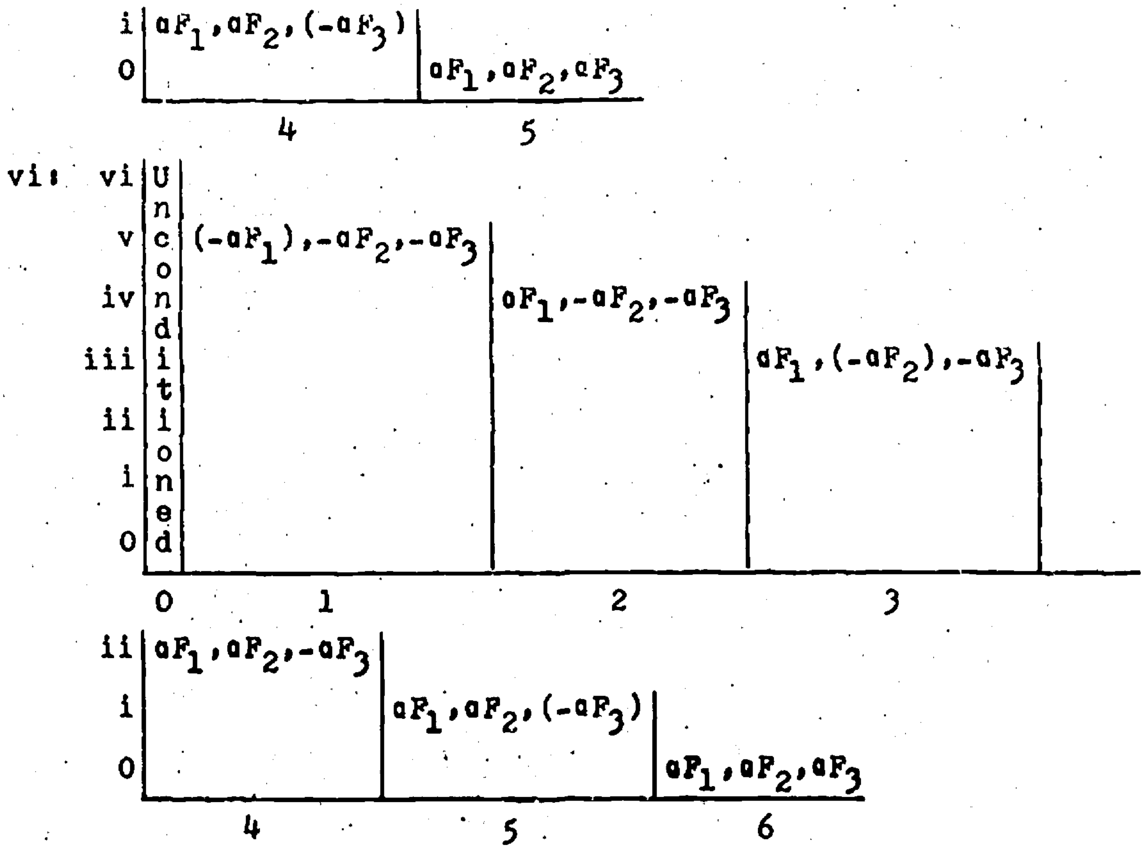


FIG. 4. Wave model of the spread of a linguistic change according to (L-3a). F indicates features; the subscript numbers indicate weightings, 1 being lightest and 3 heaviest. Parentheses indicate variability. Roman numerals denote time steps. Isolects are denoted by Arabic numerals. If the rule survives long enough, the pattern of time vi keeps moving rightward. Thus, at time vii isolect 1 has all the features changed in an unconditioned change; 2 at time vii is like 1 at time vi; 3 at time vii is like 2 at time vi; etc.

Figs. 4 and 5 display wave models of the spread of a linguistic change according to algorithms (L-3a) and (L-3b). The isolects are functions of the time steps in both instances. The small amount of phonological data pattern according to Fig. 4, while morphological and perhaps other non-phonological data spread according to Fig. 5. The wave models show how time resolves the apparent contradiction (see Becker 1967:64) between the generalization of a rule in a given isolect[7] and its petering out or apparent dis-generalization in isolects progressively more remote from the origin (isolect 0). The sociolinguistic algorithms discussed below convert the isolects in Figs. 4 and 5 into age, style, class, and sex variables and co-variables. A model of real social and physical space would be required to convert them into geographical isolects. Figs. 4 and 5 can be thought of as patterns spreading through idealized social and physical space.

Complications arise when a rule has <u>chained</u> outputs --i.e. a successsion of outputs serving as inputs to later temporal stages in the operation of the rule--as in rule (8'). The two time dimensions in rule (8') are denoted by the horizontal and vertical rows of double-headed arrows. As already suggested, an algorithm is required two co-ordinate the two aspects of time for outputs and environment changes. The required algorithm can be formulated as (L-4):

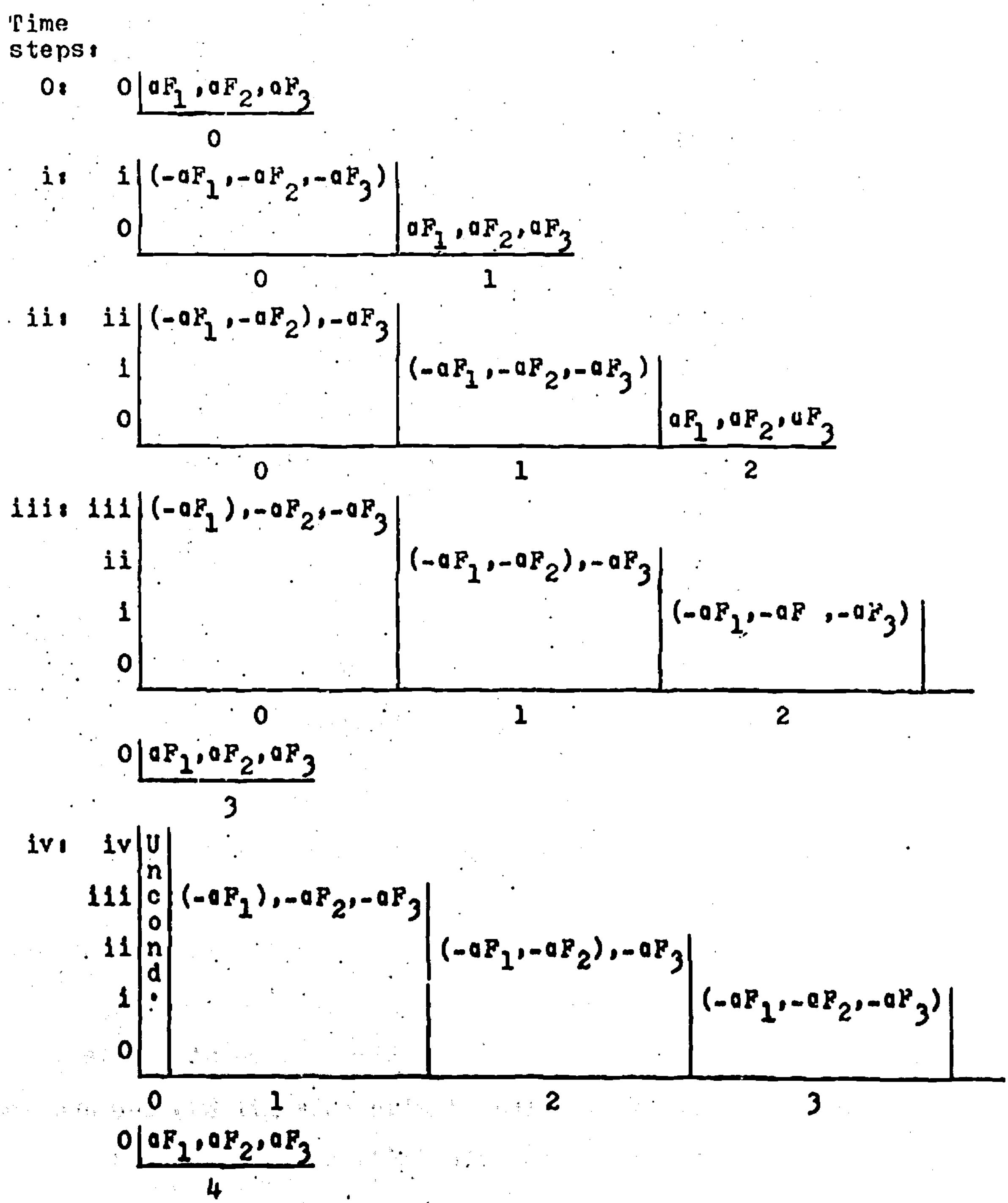


FIG. 5. Wave model with isolects as functions of time, according to algorithm (L-3b).

L-4) Given the ordering of environments according to algorithm (L-3), the first of a series of chained outputs is generated successively in all n environments minus x of a variable rule before the next-later output is generated; the generation of the earlier output in the remaining n-x (lightest) environments may be delayed until the later output has been generated in y (successively z) environments.

These facts may be shown in the following notation, where I is the input, O_1 is the earliest output, and later outputs have successively higher subscript numbers:[8]

14) $I \overset{x}{\dashrightarrow\!\!>} O_1 \overset{y}{\dashrightarrow\!\!>} O_2 \overset{z}{\dashrightarrow\!\!>} O_3$

The double-headed arrows and symbols surmounting them are the only new rule formalisms (and the double-headed arrows could be replaced by single-headed ones if the outputs where placed in parentheses to show variability) required for building rate of change into descriptive linguistic rules. The formalism may be illustrated with rule (17) (cf. [20] in Appendix A), with rule (8'), and with rule (16), to be discussed presently. The rules are given here in skeleton forms:

17) $\bar{\imath} \overset{1}{\dashrightarrow\!\!>}$ ei $\overset{3}{\dashrightarrow\!\!>}$ ae / ...	(North England)[9]
8') $\bar{æ} \overset{\forall}{\dashrightarrow\!\!>} \hat{E} \overset{3}{\dashrightarrow\!\!>} \bar{I}$ / ...	(New York City)
16) $k^w \overset{\forall}{\dashrightarrow\!\!>} p \overset{U}{\dashrightarrow\!\!>} t$ / ...	(Ancient Greek)

The symbol $\forall$ means that the earlier output occurs in all n environments before the later output is generated; this may just as well be omitted.

Fig. 7 in the first Appendix shows that the North England outputs of rule (17) form the following patterns:[10]

15)	*	*	*	*	10	9	7	*6	*5	3	2	1	●
<u>ī</u>:	a	b	c	d	e	f	g						
<u>ei</u>:		a	b	c	d	e	f			g			
<u>ae</u>:							a	b	c	d	e	f	g

Note that the earlier output (viz. <u>ei</u>) goes through all the environments but one before the later output (<u>ae</u>) begins to be generated. Output <u>ei</u> then lags three time steps behind the later output. The fact that the earlier output is generated in all the environments but one before the second output begins to be generated is denoted by the numeral 1 placed over the double-headed arrow preceding the first output. The fact that the first output subsequently lags three time steps behind the environments in which the second output is found is signified by the numeral 3 over the second arrow.

Ancient Greek rule (16) did not apply to enclitic pronominals in some lects or to isolated lexical items in several contemporary lects.[11] Since the conditions for the variability of this rule are not clear from the available evidence, the rule will serve here only to illustrate the co-ordination of its chained outputs with alterations in the environment governed by the principles formulated in the first part of this paper. A more complete formalization of rule (16) follows; note that Æolic lacks the second output, p occurring in this lect instead of t before front vowels:

$$16') \; k^{w} \overset{V}{-->>} \begin{bmatrix} u \text{ ant} \\ u \text{ rnd} \end{bmatrix} \overset{U}{-->>} [u \text{ grv}]_{\text{not Æol.}} \;/\!\!-\!\!- \begin{bmatrix} {}^{*}m \text{ nuc} \\ m \text{ grv} \end{bmatrix}$$

Three temporal steps are distinct: (i) A categorical change already complete in proto-Greek (Lejeune 1955:36) to p before non-nuclear segments; note that [nuclear] is the heavier environment feature. (ii) A similar change to p then occurs before grave nuclear segments in all post-Mycenæan lects.[12] The U over the second arrow in (16') indicates that, as the rule proceeds to the second output, m's on environment features are unmarked. (iii) The change of p to t, i.e. the unmarking of [grave], then occurs before front vowels, except in Æolic. Although [nuclear] now has a u instead of an m, it retains the asterisk certifying its categorical role. Consequently, any variation found for the second output will not be found before all [u nuc] segments (i.e. all vowels), but only before the front vowels, where output t will vary with input p.[13]

Alternatives to the U notation over the arrow are R, for reweighting (presumably) the lightest feature,[14] and D, for deleting the lightest feature (cf. principle [7]). Since two successive reweightings affect the environment of rule (8'), it may be reformulated thus:

$$8'') \begin{bmatrix} V \\ m \text{ tns} \\ u \text{ low} \\ u \text{ grv} \end{bmatrix} \overset{RR}{>>} [m \text{ low}] \overset{V}{-->>} [u \text{ high}] \;/\_\_\_ \begin{bmatrix} o \text{ voi} \\ -o \text{ cnt} \\ m \text{ nas} \end{bmatrix}$$

The notation D for deleting the lightest feature can be illustrated with the Southern States rule (see Appendix A) discussed in connection with principle (7) above. In the following formulation, the parenthesized arrow-head indicates that this part of the rule is variable (i.e. the input may remain) in some lects of English; such is not the case in the Southern States, where the first arrow is categorical. In the following formulation, the rule has been simplified by referring only to the front high tense vowel:

$$17')\quad \bar{\text{i}} \dashrightarrow (>)\ \text{ei} \overset{V}{\dashrightarrow}> \text{ae} \overset{D}{\dashrightarrow}> \text{a} \;/\; \underline{\quad\quad} \begin{bmatrix}\text{word boundary}\\ \text{nuc}\\ \text{voi}\\ \text{ant}\end{bmatrix}$$

Condition: No syllable boundary may intervene between the input segment(s) and the stated environment.

The most favored changes are those before word boundaries; next, those before nuclear peaks or glides; next, those before labials and apicals (in that order in some lects, but [+ ant] non-nuclear segments are treated as a group in the Southern States);[15] and, lastly, before velar non-nuclear segments. (The corresponding back-vowel input occurs also before palatals, the most marked consonant position following tautosyllabic vowels.) The D over the third arrow indicates that, after the changes have gone through all the environments from heaviest to lightest, the lightest feature (viz. [ant]) is then deleted and the change occurs finally (in non-Standard speech only) before velar consonants.

(iii)

In Tables 1-3 there were portrayed inter-speaker (isolectal) patterns of rule variation in different environments. Such tables represent covariations of classes and rule environments. Other covariations are common. They can be stipulated with certain sociolinguistic algorithms to be discussed in this section. Before dealing with these, however, it will clarify the discussion of such variables if Labov's (1966) distinction between changes "from below" (the threshold of consciousness) and changes "from above" (the threshold of consciousness, and usually from the highest social class) is recapitulated. Changes from above are conscious and not consistently carried through by the adults that make them. They are modeled on the speech of the prestige class, but may be either stigmatized changes avoided by the upper class or prestige changes favored by the upper class. The two types of change will be designated, respectively, [- favored] and [+ favored]. Such changes may be superimposed on the more natural (child-acquired) and consistent changes from below after a lapse of time. Changes from below may be indirectly favored as a means of social identification with one's own group. They are favored when older speakers monitoring their speech employ the norms of the younger members of their class (Labov unpublished).

Changes from below otherwise lack the [favored] distinction which characteristic of changes from above, and may begin in the lowest class or (more likely) in the lower middle class. A cross-over by the second highest class in reading word lists (Labov's styles D and D') results in a higher occurrence of prestige forms or a greater avoidance of stigmatized forms by members of this class in reading styles than are heard among members of the higher class. The attested patterns are shown in Tables 4-6; the change-from-below pattern shown there has its origin in the vernacular (most informal style, or style A) of the lower middle class. It should be pointed out (cf. Labov 1966) that different ways of measuring class membership will be required for different linguistic rules.

The sociolinguistic algorithms that convert a linear wave pattern like that seen in Figs. 4 and 5 into multidimensional covariational matrices like those in Tables 4-6 (which are only two dimensional) may now be stated. They convert the models of Figs. 4 and 5 into macromodels of a rule change. The intralinguistic patterns governing inter-speaker variation in the use of several rules are not dealt with here.

a) Algorithm (L-3a):

	A	B	C	D
4	a,b/Z,Z	a,Z,Z	a/Z,Z,Z	Z,Z,Z
3	a,b,Z	a,b/Z,Z	a,Z,Z	$\boxed{\text{Z,Z,Z,Z}}$
2	a,b,c/Z	a,b,Z	a,b/Z,Z	a,Z,Z
1	a,b,c	a,b,c/Z	a,b,Z	a,b/Z,Z

b) Algorithm (L-3b):

	A	B	C	D
4	a/Z,b/Z,c/Z	a/Z,b/Z,Z	a/Z,Z,Z	Z,Z,Z
3	a,b/Z,c/Z	a/Z,b/Z,c/Z	a/Z,b/Z,Z	$\boxed{\text{Z,Z,Z,Z}}$
2	a,b,c/Z	a,b/Z,c/Z	a/Z,b/Z,c/Z	a/Z,b/Z,Z
1	a,b,c	a,b,c/Z	a,b/Z,c/Z	a/Z,b/Z,c/Z

TABLE 4. Two-dimensional covariational matrices showing a [+ favored] change from above, with lower-middle-class cross-over boxed. Higher numbers denote higher classes; the most informal (vernacular) style is A; the most formal reading style (word lists) is D (see further Labov 1966). Note the combination, a/Z,b/Z,c/Z, which is lacking in Fig. 2.

a) Algorithm (L-3a):

	A	B	C	D
4	a,b/Z,Z	a,b,Z	a,b,c/Z	a,b,c
3	a,Z,Z	a,b/Z,Z	a,b,Z	$\boxed{\text{a,b,c,d}}$
2	a/Z,Z,Z	a,Z,Z	a,b/Z,Z	a,b,Z
1	Z,Z,Z	a/Z,Z,Z	a,Z,Z	a,b/Z,Z

b) Algorithm (L-3b):

	A	B	C	D
4	a/Z,b/Z,c/Z	a,b/Z,c/Z	a,b,c/Z	a,b,c
3	a/Z,b/Z,Z	a/Z,b/Z,c/Z	a,b/Z,c/Z	$\boxed{\text{a,b,c,d}}$
2	a/Z,Z,Z	a/Z,b/Z,Z	a/Z,b/Z,c/Z	a,b/Z,c/Z
1	Z,Z,Z	a/Z,Z,Z	a/Z,b/Z,Z	a/Z,b/Z,c/Z

TABLE 5. Two-dimensional covariational matrices showing a [- favored] change from above. The symbols are the same as in Table 4.

a) Algorithm (L-3a):

	A	B	C	D
4	a,b/Z,Z	a,b,Z	a,b,c/Z	a,b,c
3	a,Z,Z	a,b/Z,Z	a,b,Z	a,b,c/Z
2	a/Z,Z,Z	a,Z,Z	a,b/Z,Z	a,b,Z
1	a,Z,Z	a,b/Z,Z	a,b,Z	a,b,c/Z

b) Algorithm (L-3b):

	A	B	C	D
4	a/Z,b/Z,Z	a,b/Z,c/Z	a,b,c/Z	a,b,c
3	a/Z,Z,Z	a/Z,b/Z,Z	a,b/Z,c/Z	a,b,c/Z
2	Z,Z,Z	a/Z,Z,Z	a/Z,b/Z,Z	a,b/Z,c/Z
1	a/Z,Z,Z	a/Z,b/Z,Z	a,b/Z,c/Z	a,b,c/Z

TABLE 6. Two-dimensional covariational matrices showing a change from below originating in the most informal style (style A) of the second class. In (6a) the change is one step short of completion in its isolect of origin. Only the isolects shown in Fig. 2 are given here in (6b). There is no lower-middle-class cross-over. Note that classes 1 and 3 are alike.

The following sociolinguistic algorithms assume Figs. 4 and 5, where +1 isolect means one to the right and -1 isolect means one to the left (if any). When several sociolinguistic jumps are made together, their net total will govern the number of isolect differences. It should be noted that these algorithms have no general validity, but apply only to given rules in given situations, which must be ascertained empirically.

S-1) Move $\alpha 1$ isolect for $\alpha 1$ remote locale in ideal space.[16]

S-2) Move $\alpha 1$ isolect for $\alpha 1$ adjacent younger age group.[17]

S-3) Move $\alpha 1$ isolect for [$-\alpha$ male] sex.[18]

S-4) Move $\alpha 1$ isolect for--

a) $\alpha 1$ remote class from origin of a change from below.

b) $\alpha 1$ higher class in [+ favored] change from above.

c) $\alpha 1$ lower class in [- favored] change from above.

S-5) Move $\alpha 1$ isolect for--

a) $\alpha 1$ more formal style in change from below.

b) $\alpha 1$ more formal style in [+ favored] change.

c) $\alpha 1$ more informal style in [- favored] change.

S-6) In [α favored] changes to style D in the next-to-highest class, add an extra $\alpha 2$ isolects, so that the cell will show more [+ favored] or fewer [- favored] changes than style D in the highest class.

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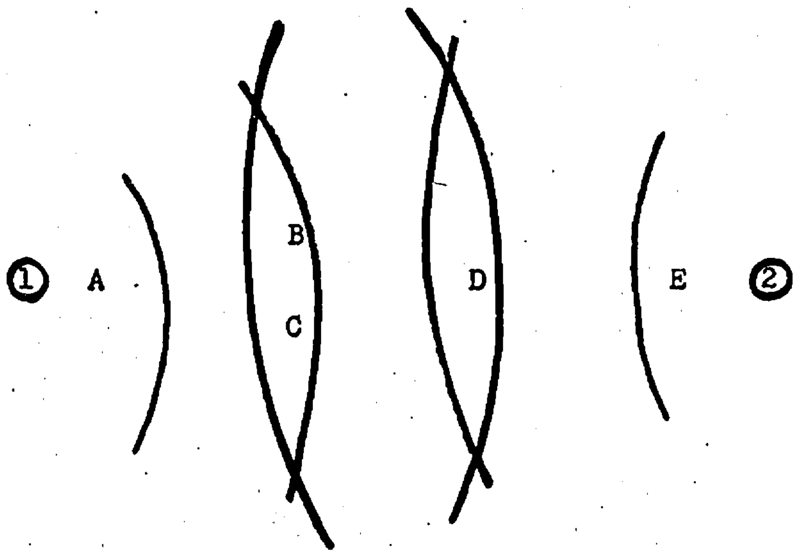
S-7) Move al isolect for change to x ethnic group. To illustrate, suppose we begin with a male speaker in cell 3-B of Table 5 and wish to determine the speech of a female speaker in cell 4-C for a social setting in which algorithms (S-3), (S-4c), and (S-5c) are valid. What the next isolect is will be determined by whether (L-3a) or (L-3b) applies. The sociolinguistic algorithms just mentioned will tell us to move to the next more-developed isolect for the sex difference, to the next less-developed isolect for the higher class and also for the more formal style--a net gain of one isolect in the less-developed direction toward the origin (i.e. isolect 0).

(iv)

Some consideration is due to the effects of overlapping waves from different origins (one example is shown in Fig. 7 in Appendix A). Fig. 6 shows the patterns that develop in the (unlikely) situation that two waves begin simultaneously and move at a uniform rate across real social or physical space toward each other. Though the patterns found at locales A,B,C,D, and E would be different in an obvious way if either of those two conditions were not met, it is important to note that the five patterns shown in Fig. 6 are the maximum variety that could ever result. Regardless of such real-space differences, the linguistic patterns and the polylectal language system would not be

Marked Rule Order	-->	Unmarked Rule Order
1) b --> c		2) a --> b
2) a --> b		1) b --> c



At A: Only rule 1. At D: 2 before 1.

At B: 1 before 2. At E: Only rule 2.

At C: Marked 1-2 reordered to 2-1.

FIG. 6. Effects of overlapping waves proceeding from origins of 1 and 2.

affected! No isolect will ever be found in which the unmarked order of the rules--2,1--changes to the marked order--1,2--unless some sort of hypercorrect change from above occurs (see principle [1]). If in a given social context both rule orderings exist (if, for example, patterns B and C are found in the same community--in different classes and/or styles), there is the possibility that all classes and styles will adopt one ordering for some words and the other for others (see Chen MS). One would expect that homier words would follow the ordering of the more informal styles and less prestigious classes, while words having a more elevated status in the local culture would follow the ordering of the more formal styles and the more prestigious classes. It is known that some principles govern the borrowing of words across language systems (Higa 1970), and it is also probable that principles can be discovered to govern the borrowing of lexical items among tautosystematic lects.

(v)

The present writing has attempted to explicate for linguistic theory the common-sense assumption that present patterns are the cumulative result of past developments. Whether the exact conventions proposed here are correct or not--and they are empirically testable--the purpose of this writing will have been achieved if it has succeeded in showing how rate could be built into a linguistic description. In other words, the attempt will have succeeded if it has been convincingly shown that the proposed conventions are along the right lines, and that, even where they are empirically wrong, the theory would be adequate if they were replaced with similar, but empirically more adequate, principles. Of course no reader who accepts the strict dichotomy between diachronic and synchronic description which is axiomatic for static paradigms of linguistics will be able to regard the whole undertaking of this study as more than nonsense. But for those whose minds are open to the dynamic paradigm of linguistic description, this study will have at least the merit that no counterexamples from among the limited amount of analysis relevant to testing the principles proposed here are known to the writer.

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APPENDIX A

In this Appendix there will considered two main instances of the diphthongization (and subsequent de-diphthongization) of the underlying high tense vowels in English--viz. data from North England and data from the Southern States. In the former data, we find positional features weighted more heavily than [voice], while the converse is true of the Southern States data. Labov's (MS a) data from Martha's Vineyard reveals a historical change from the one situation to the other in which [voice] evidently moves from a marked light weighting to its unmarked weighting (which is heavier than the positional features). Judging from the data-gathering methods used in obtaining the North England data in Kolb (1966) and in Kurath and McDavid (1961), the data are about as reasonably constant for style and even class and age (this is more true of the North England data than of the Southern States data) as could be expected. Therefore, the regional variations are the ones that are significant in these data.

Fig. 7 is a matrix generated with algorithm (L-1) and principles from the first part of this study, but ignoring variability within a given isolect. Fig. 7 shows that underlying //ū// is exempt from the weighted environments of the rule that generates the chained outputs:

18a) $\bar{\text{i}} \text{ -->> } \left\{ \begin{matrix} \text{ei} \\ \text{ɛi} \end{matrix} \right\} \text{ -->> ae}$

18b) ū -->> əu -->> ao

The further reduction of the second diphthongal output to *a* (minus the diphthongal satellite) is a separate rule in North England with a separate place of origin. In accordance with (10), //ū// changes are accelerating ahead of the de-diphthongization of the corresponding front nucleus. The Southern States form of the rule for diphthongizing the underlying high tense vowels (which are nowhere unchanged in this region, in contrast with the situation in North England) may include a final output in the chain which represents satellite loss:

$$19)\quad \begin{bmatrix} \text{u nuc} \\ \text{m tns} \\ \text{m low} \\ \text{u high} \\ \text{o grv} \end{bmatrix} \dashrightarrow \begin{Bmatrix} \text{ei} \\ \text{əu} \end{Bmatrix} \dashrightarrow\!\!> \begin{Bmatrix} \text{ae} \\ \text{ao} \end{Bmatrix} \dashrightarrow\!\!> \text{a} \;/\; \ldots$$

(The environment is omitted in the preceding rule--see [21] below; the single-headed arrow following the input indicates that the input has to be changed in the Southern States.) As Fig. 9 shows, the de-diphthongization of Southern States *ao* has hardly progressed at all. There are signs that the progressive de-diphthongization of *ao* has begun, but there is nothing in the Southern States comparable to [ə'bat] for "about," which is heard in some areas of North England.

The rule that generates the data for North England--a formalized version of (18) with added weighted environments and a condition--is (20):[1]

$$
20)\quad
\begin{array}{c}
\left[\begin{array}{l}
\text{u nuc} \\
\text{2 mid acc.} \\
\text{m tns} \\
\text{m low} \\
\text{u high} \\
(\text{D grv}) \\
\vartheta\ \text{rnd}
\end{array}\right] \\
1
\end{array}
\quad
\underbrace{
\left[\begin{array}{l}
\text{5 wd. bound.} \\
3\ \vartheta\ \text{grv} \\
3\ \vartheta\ \text{ant} \\
\text{1 voi}
\end{array}\right]
C_o \left(\left[\begin{array}{l}
\text{u nuc} \\
\text{-7 acc}
\end{array}\right] \right)
}_{2}
$$

$$
\dashrightarrow\!\!>\quad
\begin{array}{c}
1a \\
\left[\begin{array}{l}
(\text{u syl}) \\
\text{u tns} \\
\text{m high} \\
\text{m grv} \\
\text{m periph} \\
(\vartheta\ \text{rnd})
\end{array}\right]
\end{array}
\begin{array}{c}
1b \\
\left[\begin{array}{l}
\text{m syl} \\
\text{u tns} \\
(\text{D grv}) \\
\text{u rnd}
\end{array}\right]
\end{array}
\qquad 2
$$

$$
\dashrightarrow\!\!>\quad
\begin{array}{c}
1a \\
\left[\text{u low}\right]
\end{array}
\begin{array}{c}
1b \\
\left[\text{m high}\right]
\end{array}
\qquad 2
$$

Condition: Ignore all weights if input is [m grv].

FIG. 7. Isolectal groups for outputs of //ī ū// in North England (data from Kolb). Environments are symbolized by these words, shown with their abbreviations: A <u>about</u>; N <u>night</u>; D <u>died</u> (or <u>flies</u>); W <u>-wright</u>; F <u>Friday</u> (or <u>writing</u>); K <u>knife</u>; T <u>time</u>; S <u>sky</u>.

-1	0	*i	ii	*iii	iv= -7	-6	-5	-4 =4	-3	-2	-1 =1	⊕	1= -1	2	3	4= -4	*5	*6	7	8	9	10
			Au	Au	Au	Au	Au		Au	Au	Au	Au	Au	Au			Au	Au	Au	Au	Au	Au
										Aəu	Aəu		Aəu	Aəu	Aəu							
Aao	Aao	Aao		Aao	Aao	Aao	Aao	Aao	Aao			Aao			Aao	Aao						
Aa	Aa	Aa	Aa	Aa	Aa	Aa	Aa			Aa												
Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni	Ni						Ni	Ni	Ni	Ni	Ni	Ni	Ni
											Nəi		Nəi	Nəi	Nəi							
Di	Di	Di	Di	Di	Di	Di	Di													Di	Di	Di
								Dəi	Dəi					Dəi	Dəi	Dəi	Dεi	Dεi	Dεi			
												Nae										
	Wi	Wi	---	Wi	Wi																	Wi
							Wəi	Wεi							Wəi	Wεi	Wεi	Wεi	Wεi	Wεi	Wεi	
										Dae	Dae	Dae	Dae									
																	Fεi	Fεi	Fεi	Fεi	Fεi	Fεi
Wae			<u>Wae</u>			Wae			Wae	Wae	Wae	Wae	Wae	Wae								
		Fae	<u>Fae</u>	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae	Fae						
																		Kεi	Kεi	Kεi	Kεi	Kεi
			Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae	Kae					
																			Tεi	Tεi	Tεi	Tεi
Fa	Fa																					
Ka	Ka	Ka																				
				Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae	Tae				
																					Sεi	---
Ta	Ta	Ta	Ta																			
					Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae	Sae		<u>Sae</u>
Sa	Sa	Sa	Sa	Sa																		

Unattested isolects have starred numbers. This matrix is generated with one change per new isolect. The earlier origin is at ⊕; the later origin of de-diphthongization is at O. Overlapping isolects are found between the two origins as the waves meet each other. Two deviant data that do not fit the pattern for //ī// are underlined; --- shows where they should occur to fit the pattern. Fig. 8 maps these isolects onto real geographical space.

Table 7 provides a calculus of the weighted environments of rule (20). Heavier numbers denote heavier-weighted features. When plus-valued, they make the environment heavier; when minus-valued, they make an environment lighter. The occurrence of the rule in a given environment implies its occurrence in a heavier environment.

Fig. 8 is a real-space mapping of the isolects, illustrating a new scheme for displaying such materials proposed by the writer recently. It shows the futility of trying to do spatial "dialectology" with isoglosses on a geographical map. On the other hand, since Fig. 7 displays linguistic (rather than real-space) patterns, it makes the notion of regular linguistic change a much more sanguine possibility. Time, not space, is the key to Figs. 4 and 5.

Item (15) above shows how logarithm (L-4) applies to Table 7. The interpretation of Table 7 creates something of a paradox. As the wave grows, it moves away from its origin. But since this means that the older forms are the most remote ones, and conversely, the developments of the wave are read in the reverse direction of that of time, viz. from the farthest spread of the wave towards its origin (i.e. centripetally).

Environment:	[-7 acc]	[5 wd.b.]	$\begin{bmatrix}3\ \text{grv}\\3\ \text{ant}\end{bmatrix}$	[2 m.ac.]	[1 voi]		TOTAL
1. sky	--	+5	--	-2	-1	=	+ 2
2. time	--	-5	+6	-2	+1	=	0
3. knife	--	-5	+6	-2	-1	=	- 2
4. Friday	+7	-5	-6	-2	+1	=	- 5
5. writer	+7	-5	-6	-2	-1	=	- 7
*-sìde	--	-5	-6	+2	+1	=	- 8
6. -wrìght	--	-5	-6	+2	-1	=	-10
7. died (flies)	--	-5	-6	-2	+1	=	-12
8. night	--	-5	-6	-2	-1	=	-14
about	--	--	--	--	--		--

TABLE 7. Calculus of weighted environments in rule (20). Minus-weights give plus values for minus-features, and conversely. Note that -wright is the second part of words like cartwright; -side is not attested in the data on which Fig. 7 has been based.

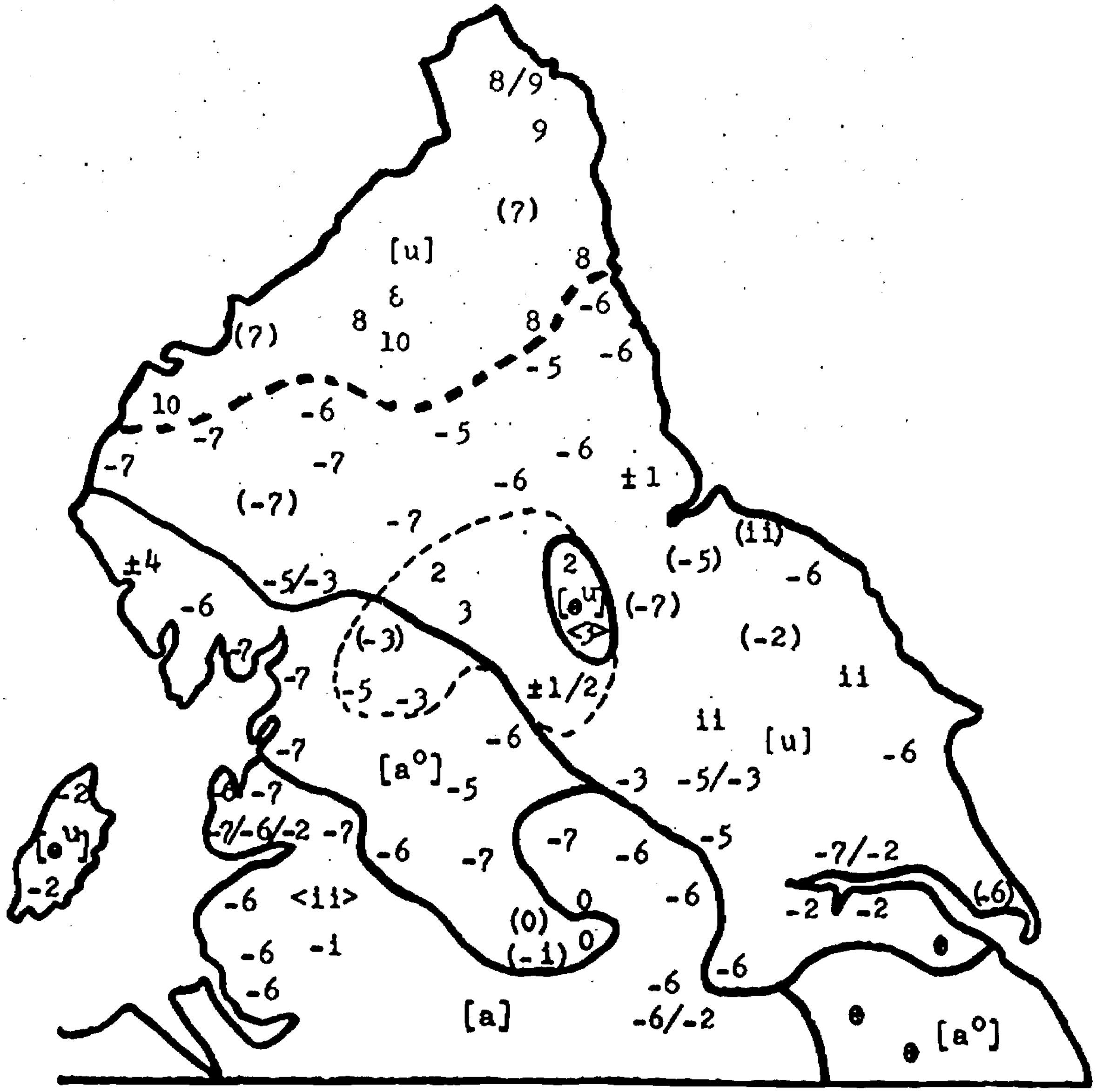

FIG. 8. Mapping of outputs of //ū// in <u>about</u> in North England (adapted from Kolb, ignoring minor variants). The narrow broken line surrounds the area having [e^{i}] in <u>geese</u>, possibly representing a re-ordering of the rules affecting the outputs of //ī// and //ē//. The numbers represent the isolects of //ī// outputs in Fig. 7; ( ) signifies one deviation from the pattern; < > signifies two deviations. Note that pronunciations of <u>flies</u> or <u>writing</u> were substituted for those of <u>died</u> or <u>Friday</u>, respectively, when necessary to make the isolectal patterns consistent. Most of the deviations are due to forms with /a/. O is not far to the east of Manchester; isolect ⊕ appears to center on Lincoln. Only two lects have as many as two deviations from the pattern. The heavy broken line demarcates the northern limit of the second wave originating from O (isolect -7 = +iv) and of the minus-numbered isolects originating from ⊕.

FIG. 9. Southern States lectal pronunciations of words shown in Table 8. (<u>Tile</u> is like <u>tire</u>; <u>try</u>, like <u>time</u>; <u>like</u>, like <u>night</u>; <u>fowl</u>, like <u>hour</u>; and <u>cow</u>, like <u>loud</u>.) The origin is at 0, and the lines represent concentric perimeters of a spreading wave generated according to the principles explained in the text. The figures designate isolects. The fronting and backing of /a/, though shown here for convenience, may be generated by a rule later than rule (21).

0	1	2	3	4	5	6	7	8	9
					eu about	eu about	eu about	eu about	eu about
	æo about	æo about	æo about	æo about					
a about	æo loud	æo loud	æo loud	æo loud	æo loud	æo loud	æo loud	æo loud	ɑo loud
a loud				æo hour	æo hour	æo hour	æo hour	æo hour	ɑo hour
a hour	a hour	a hour	a hour						
		R A	D I	U S					
						əi night	əi night	əi night	əi night
		ae night	ae night	ae night	ae night		əi tiger	əi tiger	əi tiger
a night	a night		ae tiger	ae tiger	ae tiger	ae tiger			
a tiger	a tiger	a tiger						ae time	ɑe time
a time	a time	a time	a time	a time	a time	a time	a time		ɑe tire
ɑ tire	ɑ tire	a tire	a tire	a tire	a tire	a tire	a tire	a tire	

0 - Unattested?
1 - Substandard general.
2 - Semistandard general.
3 - Standard general.
4 - Standard Atlanta, etc.
5 - Roanoke.
6 - Alexandria, Richmond.
7 - Fredricksburg, Lexington; with ao: Raleigh, Columbia.
8 - Norfolk, Wilmington; with ɑ: Beaufort.
9 - Charleston.

The Southern States patterns are displayed in Fig. 9.[2] Rule (21), which generates them, shows a reweighting of [voiced] relatively to [anterior], as compared with rule (20).[3]

21)
$$
\begin{array}{cc}
\left[\begin{array}{rl} & \text{u nuc} \\ & \text{m tns} \\ & \text{m low} \\ & \text{u high} \\ -1 & \alpha \text{ grv} \\ & (\gamma \text{ rnd}) \end{array}\right] &
\left[\begin{array}{l} \text{4 wd. bound.} \\ \text{4 nuc} \\ \text{3 voi} \\ \text{2 ant} \end{array}\right] \\
1 & 2
\end{array}
$$

$$
\longrightarrow
\begin{array}{c} \text{1a} \\ \left[\begin{array}{l} (\text{u syl}) \\ \text{u tns} \\ \text{m high} \\ \text{m grv} \\ \text{m periph} \\ (\gamma \text{ rnd}) \end{array}\right] \end{array}
\begin{array}{c} \text{1b} \\ \left[\begin{array}{l} \text{m syl} \\ \text{u tns} \\ (\alpha \text{ grv}) \\ \text{u rnd} \end{array}\right] \end{array}
\quad 2
$$

$$
\longrightarrow\!\!> \quad
\begin{array}{c} \text{1a} \\ \left[\text{u low}\right] \end{array}
\quad
\begin{array}{c} \text{1b} \\ \left[\text{m high}\right] \end{array}
\quad 2
$$

$$
(\longrightarrow\!\!> \quad \text{1a}, \quad \emptyset, \quad 2)
$$

Condition A: No syllable boundary between 1 and 2.

Condition B: In 2, [2 ant] --> [-2 ant] / $\left[\overline{}\atop \text{- voi}\right]$.

Environment:	[4 wd.b.]	[4 nuc]	[3 voi]	[2 ant]	Input: [-1 grv]	TOTAL
1. wire, tile	-4	+4	+3	-2	+1	= + 2
2. try	+4	-4	-3	--	+1	= - 2
3. time	-4	-4	+3	+2	+1	= - 2
4. hour, fowl	-4	+4	+3	-2	-1	= 0
5. cow	+4	-4	-3	--	-1	= - 4
6. loud	-4	-4	+3	+2	-1	= - 4
7. tiger, Geiger	-4	-4	+3	-2	+1	= - 6
8. night	-4	-4	-3	+2	+1	= - 8
9. like	-4	-4	-3	$\boxed{+2}$	+1	= - 8
10. about	-4	-4	-3	+2	-1	= -10

TABLE 8. Calculus of weighted environments in rule (21). Note: [+ word boundary] ⊃ [- nuclear, - voiced]. Note that the weight of 2 = 3, 5 = 6, and 8 = 9; the last is due to the special condition on the rule affecting the boxed number. The satellites /ɪ e ə/ are not apical, and therefore not anterior.

The parentheses around the last output express the doubt in the writer's mind as to whether the loss of the satellite (de-diphthongization) is part of rule (21), or a separate rule, as in North England. Since the loss of the satellites is correlated with the other outputs in the isolectal patterns of Fig. 9, it would seem that we have a single rule here. But if so, algorithm (L-4) is clearly inadequate to correlate the outputs with the different weighted environments. The main reason is that an input feature, viz. [grave] (which cannot be taken care of by principle [10], but must have a relative weight vis-à-vis the weighted environment features), has to correlate alternative outputs for each chained output in the different environments.

Beginning with an early pattern on the order of isolect 9 in Fig. 9, the single changes differentiating the isolects are:

22) 8: front-vowel de-diphthongization in env. 1.
    7: front-vowel de-diphthongization in envs. 2,3.
    6: front-vowel lowering of mid diphthong in env. 7.
    5: front-vowel lowering of mid diphthong in envs. 8,9.
    4: back-vowel lowering of mid diphthong in env. 10.
    3: back-vowel de-diphthongization in env. 4.
    2: front-vowel de-diphthongization in env. 7.
    1: front-vowel de-diphthongization in envs. 8,9.

By extrapolating to a hypothetical isolect *10, we can say that three occurrences of de-diphthongization are followed by three of mid-diphthong-lowering, and this by three more of de-diphthongization. Moreover, the front-vowel outputs (beginning with isolect 8) run through all the environments in order; the first two belong to the de-diphthongization phase of the output chain, while the next two back up to the next-earlier output in the chain. This is followed by two occurrences of back-vowel changes--first, a lowering and then (in isolect 3) a de-diphthongization. Finally, there are attested in isolects 2 and 1 the remaining two possible de-diphthongizations of the original front vowel.

Formulating a reasonable algorithm to construct a matrix for the foregoing data is a problem that must be put off to a later time. Its purpose would be to go beyond (L-4), which correlates chained outputs with successive environments, to correlate these two with alternative moves of different inputs (front and back vowels in rule [21]).

If Fig. 9 is the matrix of a single rule, it will be clear to anyone who considers the relative geographical locations of the isolects illustrated there that the wave spread from an inland origin back to the Atlantic Coast in a direction the reverse of the direction of migration. This renders much of the studies of migrations by dialectologists a little beside the point. But it fits neatly together with the earlier comments on the futility of doing "dialectology" in real-space, rather than on the basis of the linguistic patterns in the data.

The scope of the present writing precludes dealing with the varieties of rules (20, 21) found in eastern Pennsylvania, western New York and Pennsylvania, Toronto, Scotland, and especially on Martha's Vineyard. The importance of Labov's (MSa) continuing work on data from the last-named locale is bound to over-shadow the data presented above in this Appendix because of the detailed instrumental documentation of change from a rule something like (20) to something quite like (21).

The writer is at present investigating interesting examples (in addition to the correlation of rule [20] with the de-diphthongization rule) on the interaction among several phonological rules of a language, in the hope of being able to formulate an adequate principle governing their possible relations in given linguistic situations. It should be pointed out in connection with Labov's (1963) early work on Martha's Vineyard that hypercorrect treatments of the diphthongs from the underlying tense high vowels depended on the intentions of young people to leave the island or to stay there and identify with its people (the latter group showed more hypercorrection). Algorithm (S-7) accordingly needs to be broadened to cover this and other eventualities.

APPENDIX B

Suppose the following theorem derived from principle (1):

22) Outputs of linguistic rules (and of reorderings of rules) are simpler--less marked--than their inputs, except in the instance of adult changes from above.

If all values of all features are marked in adult speech, as maintained above, clearly adult changes must be excepted from the foregoing principle.[1] For those who wish to dichotomize diachronic and synchronic changes, the principle, if correct, will hold valid in either case. Given such a principle, any single example of a linguistic change will offer confirmatory or disconfirmatory evidence for marking or weighting values,[2] since outputs must have fewer _m_'s, or at least lighter-weighted _m_'s where the number of output _m_'s equals the number of input _m_'s. This means that it is not necessary to ransack all the languages of the world to determine marking values and weighting hierarchies, as is the case with regard to many linguistic phenomena. An inspection of the weights of the features in a given language-specific rule will not tell us anything about the unmarked relations, but a language-specific change from one weighting to another will, since these are presumably unidirectional.[3]

Features whose marking values are dependent on those of other features presumably have a smaller relative weighting than the others. This criterion co-incides with the deductions made about the unmarked hierarchy of feature weightings from rule changes. The features having more effect than others on the operation of a rule are the heavier ones, marked with larger numbers,[4] though their plus or minus value (depending on the plus or minus value of the feature in question) will have opposite effects--aiding or hindering the operation of a given rule, respectively, as shown in Tables 7 and 8.

The evidence accrued thus far suggests the following provisional unmarked weighting hierarchy:[5]

14. segmental
13. nuclear
12. accent
11. nasal
10. continuant
9. voice
8. tense
7. low
6. high
5. grave
4. anterior
3. sulcal (?)
2. lateral
1. round

The empirical evidence confirms the logic of weighting boundary features heavily, since they are not accompanied by non-boundary features, other than [- nuc, -syl, -acc, - voi].[6] The reweighting of [nas] ahead of manner and place features in rule (8') confirms the expectation that a fundamental air-stream feature would have a heavy weight. Just as the value of accent features depend on [syl] or [nuc], so continuance and voicing depend on nasality. Voicing also depends on nasality in some degree. But rule (8') shows how [cnt] moves up above [voi] in the weighting hierarchy. See Bailey and Parker for the relative weightings of 1, 5, 6, and 7 above. Since the relationship between [low] and [high] is fixed, a choice of one over the other as the heavier is rather arbitrary, though the most unmarked vowel is a low one, a fact that makes [low] a better choice for the independent feature of the two in the hierarchy of feature dependencies. Because of their fixed relationship, these two features probably never reweight with respect to each other. Therefore, principle (7) combines with a rule for Icelandic stated by Anderson (1969:38[2.16,17]), showing the generalization of an environment [u tns, m low, m high] to [u tns, m low], to show that [high] is lighter than [low]. Since <u>tk</u> and <u>tp</u> frequently metathesize, and since this involves a distinction of [± grave], while metatheses involving [anterior]--though attested--are infrequent, we conclude that [grv] is heavier than [ant]. Rounding is the most parasitic characteristic of all; it depends for its marking values on laterality, which seems to be quite low in the hierarchy.

The manner in which obstruents are reduced to glides (voicelessstops becoming a glottal stop, voiceless fricatives becoming [h], voiced ones becoming [ɦ], liquids becoming [w] or [y], etc.) suggests a general feature-stripping phenomenon in which all features lighter than voice, or even continuance, may drop out; though gravity and rounding may be required for some marked distinctions that may remain.

Footnotes

[1]Many of the ideas in this study have grown out of discussions with Gary J. Parker, with whom the paper has been discussed at many stages. The idea of building directionality and rate of change into a linguistic description was first envisioned by Labov (1966:10).

[2]In data from the French patois of Charmey, Switzerland (Labov MSb:26), the change of a to ao is earliest before labials. The diphthongization of light front vowels is most noticeable in the prelabial environment in the Southern States, where also the change of light *e to /ɪ/ occurs before the more fronted nasals m and n, rather than before those farther back in the mouth. The very reliable evidence on the developments of //ī ū// in Appendix A shows that changes affecting //ī// begin in the environment specified by principle (2). Moreover, the changes occur before apicals earlier if the vowel is paroxytonic or tertiarily accented than if it is oxytonic. It is notable in this connection that DeCamp (1959:60) found naughty merged with notty in San Francisco while caught was still distinct from cot. Labov (personal communication) has also found dawn merged with don in the Western States earlier than the merger of hawk with hock. All these data agree with the variation found in the developments of //ī// in North England. It is also interesting to observe that the velars lag behind the other consonants in the High German sound shift. Slight shortenings of a vowel occur first in

the prelabial environment (Lehiste 1970:20), apparently as the result of universal physiological conditioning. There is variation as to whether the next-shorter vowel environment is the pre-apical or the prevelar one. The reasons for this variation will appear below. It is well-known that labials have heavier and shorter aspiration than consonants farther back in the mouth; again, this is due to physical reasons.

[3]The different rates of the three environments may be due to Labov's (MSa) spectrographic findings that, at least in New York City English, prenasal vowels have the most peripheral track during their raising in the vowel space, while vowels before voiceless fricatives have the least peripheral track.

[4]Parentheses indicate environments where variation between the input and the output of the rule is found, as well as the variable output itself. An asterisk denotes a non-variable environment in a variable rule (see further in Labov 1969). Inverted alpha and other variable coefficients do for m's and u's (denoting marked and unmarked values, respectively) what uninverted variables do for plusses and minusses. The formulation of rule (8) is bidimensional. The double-headed arrows in the horizontal dimension denote input-output stages in a rule generating a chain of successive changes. The successive environments formulated in the vertical dimension represent feature reweightings in time.

[5]The feature [tense] has an unmarked weighting that is heavier than the vowel height features, since their markedness depends on it. For the relations among the vowel height features and [grave], see Bailey and Parker. Note that [high] is redundantly marked when [low] is unmarked, i.e. plus-valued. But when [low] is marked, the marked value of [high] is minus, since high vowels are the next most unmarked vowels after low ones.

[6]The writer would be far from his present understanding of these matters, had he not profited from reading Bickerton MS and from correspondence with Bickerton concerning these matters, both of which have been extremely enlightening. The writer's understanding of these matters has also greatly profited from Fasold 1970, Wang and Cheng 1970, and Chen and Hsieh 1970. The writer's debt to Labov is evident on every page. Such scholars are not responsible, of course, for misinterpretations of them on my part.

[7]The only case where rules dis-generalize in a given locale is presumably that found in the gradual approximation of a creole to a standard variety of a language. Thus, Hawaiian "The boards take" and "The keys lose" is <u>too</u> general for English, which, however, allows "Winstons smoke smoothly" and "This book translates easily," as well as sentences with intransitive "move, break," etc.

(The Hawaiian Creole sentences cited above are from the data of the Labov 1970 summer project at the University of Hawaii; I am indebted to Richard Day for bringing them to my attention.)

[8]From this point on in the exposition parentheses are omitted after double-headed arrows, since rules with chained outputs are presumably always variable rules. The use of double-headed arrows even for unchained outputs in variable rules would eliminate the need for parentheses around such outputs.

[9]The reduction of the diphthong to simple a is a rule which is separate in time and place.

[10]The numbers refer to isolects, viz. those in Fig. 7. The asterisks to the left of 10 are extrapolations from the data of Fig. 7. The reasons for omitting isolects 8 and 4 should be evident from Fig. 7. The letters in (15) represent the successively heavier environments of Fig. 7.

[11]Aeolic changes $*k^w$ to t in -te ("and"), adelpheós ("brother"), and télos ("end"). For such unmarking in connection with lexical exceptions, cf. Bailey 1968, which, however, refers to rule-ordering. Note, on the other hand, that Ionic has kõs (Att. põs, "how?"), and that Thessalian has -kis ("some").

[12]A change ordered earlier than (16') deletes the labialization of k^w next to u and preceding y. The temporal ordering of the outputs in rule (16') disagrees with Lejeune 39.

[13]The variation is much clearer with the voiced correlate of $\underline{k}^w$, where variation occurs before $\underline{i}$ and sometimes even before $\underline{e}$ (e.g. Attic bélos, sbénnūmi).

[14]If it is always the lightest feature that gets reweighted, a principle stating this should be added to those given in the first part of this paper.

[15]As noted in Bailey and Parker, the articulatory positions for consonants following a tautosyllabic vowel (but not elsewhere) are the following:

a) velars (most unmarked): [u grv, u ant]

b) labials (next-most unmarked): [u grv, m ant]

c) apicals (next-most marked): [m grv, u ant]

d) palatals (most marked): [m grv, m ant]

The m for labials is lighter than the m for apicals.

[16]That is, remote from the origin (isolect 0). A real-space model is required to convert the ideal-space patterns into those of real geography. See further in section (iv) of this study below.

[17]The age divisions corresponding to minimal isolectal differences are still unknown. But the ages of 13 and 18 are known to represent turning points in linguistic development.

[18]In some cultures the appropriate feature would be [female], instead of [male]. But in Europe and the non-aboriginal cultures of America, females' linguistic developments outdistance those of males (Labov MSb).

Footnotes, Appendix A

[1]Inverted alphas and betas are (variables) to m and u values what uninverted alphas and betas are to plus and minus values of features. Weights are calculated according to plus and minus values; but a minus-weight gives a plus value for a minus feature, and conversely. See the calculus in Table 7. I have used the feature [tense] where I prefer the more meaningful [wide pharynx]. The accent features used in rule (20) are ad hoc features. Stockwell's [peripheral] is necessary to specify the central vowel; but note that some isolects in Fig. 7 do not have a central-vowel peak developed from //ī//. To include all such considerations in rule (20) would make it too complex to understand, without contributing significantly to the purposes of the present exposition. Diphthongal peaks are both nuclear and syllabic, but satellites are [+ nuc, - syl]; [- nuc] ⊃ [- syl]. The beta-linking of [grv] and [ant] is due to the lack of evidence in the North England data for the occurrence of the front tense high vowel before velars; the corresponding back vowel may not occur before velars in English, and tiger and Geiger are the only common examples of the front vowel in this environment.

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[2]The data in Fig. 9 are essentially from Kurath and McDavid (1961), but I have supplied some environments and adapted the transcriptions, on the basis of my knowledge of English in this region, to the needs of this study.

[3]Rule (21) is formulated to handle all three tense high vowels: <u>ī</u> --> əi . . .; <u>ū</u> --> əu (əu) . . .; <u>ǖ</u> --> əi . . . (as in <u>joint</u>).

<u>Footnotes, Appendix B</u>

[1]The change from open-syllabled Old Church Slavonic to the complex clusters in Russian and Polish caused by vowel syncope remains a problem for principle (22), which may have to be modified in order to stand.

[2]It was Labov (1969) that first announced that one kind of sound change, perhaps the most basic one, involves reweighting environment features.

[3]Unmarking may involve rule ordering as well as feature values and weightings. See the first chapter of Anderson (1969) for an excellent treatment of the latter subject.

[4]The weighting numbers obviously have no absolute objective value. They serve merely to establish mutual weighting relations.

[5] The ultimate reasons for these relative weightings may be physiological or acoustical. I have argued previously that the reason why apicals are unmarked syllable-initially, whereas grave consonants are unmarked after a tautosyllabic vowel, is that a nerve signal from the brain to the tongue --assuming one signal per syllable--would activate the more flexible apex of the tongue sooner than the dorsum. In the same way that this would affect marking values of features, certain physiological mechanisms might affect weighting hierarchies. Also, voicing depends on nasality, since voiceless nasals in most environments would be inaudible--an acoustic consideration.

[6] Labov (MSa) shows how the boundary feature goes from lighter to heavier (with respect to [nuclear]) in rule (12). Harlem pre-adolescents have the rule with the marked weightings. These change to the unmarked weightings during their teens. Nonstandard white English has the unmarked weightings in rule (12).

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